

(19)



Europäisches Patentamt

European Patent Office

Office européen des brevets

(11)



EP 0 691 599 A2

(12)

## EUROPEAN PATENT APPLICATION

(43) Date of publication:

10.01.1996 Bulletin 1996/02

(51) Int. Cl.<sup>6</sup>: G05D 1/03

(21) Application number: 95303783.5

(22) Date of filing: 02.06.1995

(84) Designated Contracting States:  
DE FR GB

(30) Priority: 05.07.1994 JP 153288/94

(71) Applicant: HITACHI, LTD.  
Chiyoda-ku, Tokyo 100 (JP)

(72) Inventors:

- Takano, Kazuaki  
Mito-shi (JP)

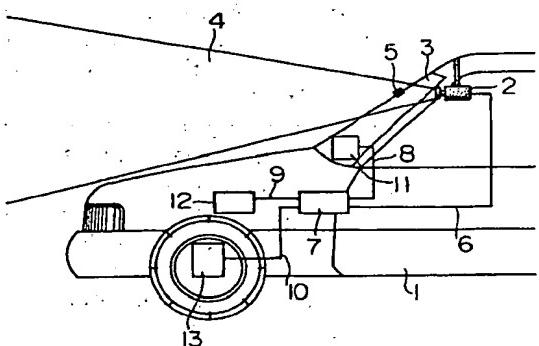
- Monzi, Tatsuhiko  
Hitachinaka-shi (JP)
- Tanaka, Yasunari  
Mito-shi (JP)
- Ondoh, Eiryoh  
Hitachinaka-shi (JP)
- Shioya, Makoto  
Tokyo (JP)

(74) Representative: Molyneaux, Martyn William  
London WC1V 6RR (GB)

## (54) Environment recognition device provided with image pickup device

(57) An environment recognition device formed in such a manner that an image sensor (2) is installed so that an image sensor mounting location recognition mark (5) falls within an image pickup area (4), means for comparing mark locations the images of which are picked up sequentially by means of the image sensor (2) with respect to the initial location of the recognition mark (5) in the image pickup area (4) is provided, and, when it is detected that the mark location recognized sequentially has changed with respect to the initial location, an indication signal for indicating that correction of the location of installing the image sensor (2) is required is outputted, thereby to prevent erroneous decision in image processing when the mounting position changes by vibration, contact or the like.

FIG. I



EP 0 691 599 A2

**Description****BACKGROUND OF THE INVENTION**

The present invention relates to an environment recognition device using an image pickup device, and to a device and a method for recognizing environment around a vehicle used in an on-vehicle device for recognizing external environment of a vehicle for supporting safety driving of a vehicle for instance and, to be concrete, using an image sensor such as a CCD camera as the image pickup device.

Conventional environment recognition devices include, for example, one that is disclosed in JP-A-3-203000 that performs environment recognition using an image pickup device such as a CCD camera installed in a vehicle as an image sensor for the purpose of supporting safety driving of the vehicle. Further, as disclosed in JP-A-1-281600, a device for deciding whether there is a preceding vehicle within a safe distance or not based on image data of an image pickup device is also proposed. Since the picked up image data are different depending on the mounting location and the set angle of the image sensor in the environment recognition device using the image pickup device described above, univocal relative relationship between image data and recognition object information such as the distance between vehicles is adjusted after the image sensor is mounted and fixed. Or, the mounting location and the set angle of the image pickup device are adjusted so that the preset relative relationship between image data and the recognition object information may be obtained.

In the conventional environment recognition device described above, however, compensation for the change with the passage of time of the mounting location and set angle of the image sensor has not been taken into consideration. As a result, there has been such a possibility that, even when the mounting location and the set angle of the image pickup device change with respect to the initialized location by vibration, contact or the like, an image processing means forms erroneous judgement based on inappropriate information of the image pickup device without noticing the change.

A device in which a point is provided at a principal position on the road in a detection area is set based on the position of this point in order to correct deviation of the detection area of a laser device as a vehicle detection device installed on the road has been disclosed in JP-A-5-62099. Further, a monitor for deciding the magnitude of the portion where brightness exceeds a critical value by comparing image information inputted from an image sensor with reference image data, thereby to distinguish between the existence of an invader and deviation of the mounting location of the image pickup device by vibration or the like has been disclosed in JP-A-3-97080. In these prior arts, however, nothing has been described on the detection of deviation of the mounting location of an image sensor (an image pickup device), and further, the effects of the invention are influenced largely depending

on what is the point of the former gazette and on what will be taken as the reference image data in the latter gazette. Therefore, appropriate setting of the point and the reference image data has been difficult.

5

**SUMMARY OF THE INVENTION**

It is an object of the present invention to prevent erroneous decision based on inappropriate information from 10 an image pickup device when the mounting location of an image pickup device has changed with the passage of time due to vibration, contact or the like with respect to an initialized location.

The present invention has been described with an 15 environment recognition device of a vehicle as an example, but it can also be applied for preventing erroneous recognition due to deviation of a mounting location of an image pickup device when the environment is recognized from image pickup data in a general environment 20 recognition device.

In an environment recognition device of the present invention, an image pickup device is installed so that a 25 recognition mark for specifying the initial mounting location of an image pickup device falls within an image pickup area in order to achieve the above-mentioned object. To be concrete, there is provided means for detecting and comparing location data of practical marks the images of which are picked up sequentially by the 30 image pickup device with respect to the initial location data of the recognition mark in the image pickup area.

Further, a mark showing a mounting location of an 35 image pickup device is set up in a vehicle mounted with the image pickup device. The location data of the mark are inputted to a processing unit as one of peripheral information.

In a method of recognizing environment from image 40 data according to the present invention, the data showing the mounting location of an image pickup device are used as one of image processing data.

In an environment recognition device of the present 45 invention, a mark for specifying a mounting location of an image pickup device is set up in a portion that becomes within the image pickup area of the image sensor, and there are provided a memory portion for storing an initialized location of this mark and means for detecting and comparing the mark locations thereafter one after another in the image processing device. Further, when the sequentially recognized mark location has 50 changed with respect to the initialized location, it is informed by an alarm or the like that the set location of the image sensor is inappropriate and requires correction, or the posture of the image sensor is corrected automatically or the image data are corrected.

Besides, in the present invention, the word "environment" is used in a broad sense, and indicates all the objects that can be viewed as images. In the embodiment, it is a landscape around the vehicle, but it may be a work along a production line, cloths, or an indoor landscape in other examples.

## BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic side view showing a rough structure of a first embodiment of the present invention;  
 Fig. 2 is a block diagram showing a structure of a signal processing portion in the first embodiment;  
 Fig. 3 is a flowchart showing a processing operation of the embodiment;  
 Fig. 4 is an image window showing the operation of the embodiment;  
 Fig. 5 is a schematic side view showing a structure of another embodiment of the present invention;  
 Fig. 6 is an image window showing the operation of the other embodiment;  
 Fig. 7 is a schematic side view showing still another embodiment of the present invention;  
 Fig. 8 is a block diagram showing a structure of a signal processing portion of the embodiment shown in Fig. 7;  
 Fig. 9 is a flowchart showing signal processing operation of the embodiment shown in Fig. 7;  
 Fig. 10 is an image window for explaining the operation of the above-mentioned embodiment;  
 Fig. 11 is a schematic perspective view showing still another embodiment of the present invention;  
 Fig. 12 is a block diagram showing a signal processing portion of still another embodiment of the present invention;  
 Fig. 13 is a flowchart showing a signal processing operation of the embodiment shown in Fig. 12;  
 Fig. 14 is a schematic perspective view showing still another embodiment of the present invention; and  
 Figs. 15A and 15B show general views for explaining the operation of the embodiment shown in Fig. 14.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of the present invention will be described hereinafter with reference to the drawings. At the beginning, a general structure of an environment recognition device for a vehicle that is an embodiment of the present invention will be shown with reference to Fig. 1. An image sensor 2 for picking up an image of environment outside a vehicle is installed on its own vehicle 1. Further, a mark 5 is stuck on a windshield 3 so that the location thereof falls within an image pickup area 4 of the image sensor 2. Further, the image sensor 2 is connected to an image signal processing unit 7 by an image signal line 6, and the image signal processing unit 7 is also connected to a warning device 11, a brake control unit 12 and a steering control unit 13 through an alarm signal line 8, a brake control signal line 9 and a steering control signal line 10, respectively.

Fig. 2 shows an internal structure of the image processing device 7, but it is divided roughly into five portions, i.e., an A/D converter 71 for converting an analog signal from the image sensor 2 into a digital signal, an

image memory 72 for taking in image data in a pixel unit, an image processing portion 73 for recognizing and computing a relative location of its own vehicle to the external environment, an image sensor location change deciding portion 74 for detecting and deciding location deviation of the image sensor with respect to the initialized location, and a danger avoidance deciding portion 75 for deciding control of issuance of warning, brake and steering. The image processing portion 73 is composed of a preceding vehicle recognition portion 731, a distance between vehicles arithmetic portion 732, an own vehicle lane recognition portion 733 and a location relationship between own vehicle and lane arithmetic portion 734. The image sensor location change deciding portion 74 is composed of an initial mark location storage portion 741 connected to an initial mark location setting device 14, a mark extracting portion 742, a mark location detecting portion 743 and a comparator 744. The danger avoidance deciding portion 75 is composed of a risk deciding portion 751, a warning issuance deciding unit 752 and an actuator drive deciding unit 753.

Next, the operation of the present embodiment will be described with reference to Fig. 2 to Fig. 4. In Fig. 2, the image data in front of its own vehicle picked up by the image sensor 2 are converted into 8-bit digital data for instance by means of the A/D converter 71 and stored in the image memory 72. Recognition of a preceding vehicle (731) and computation of the distance from the preceding vehicle (732) are performed in the image processing portion based on these data. Further, recognition of its own vehicle lane (733) and computation of location relationship between its own vehicle and the lane (734) are performed in parallel therewith. Abnormal approach to a preceding vehicle, lane jutting out running and so on are decided in the risk deciding portion 751 based on these results of computation, and when it is decided that collision can be avoided by informing a driver of the fact with warning, a warning for attracting a driver's attention to the collision avoidance operation is given from the warning device 11 by the decision of the warning issuance deciding unit 752. On the other hand, when it is decided in the risk deciding portion 751 that collision is unavoidable by warning only, brake control (12) and/or steering control (13) is performed by the decision of the actuator drive deciding unit 753, thereby to perform collision avoidance on the car side without operation by the driver.

The foregoing shows general operation of the collision avoidance unit, but a characteristic portion of the present embodiment will be described with reference to Fig. 2 to Fig. 4 in the next place. When initialization of the image sensor is completed, the initial mark location setting device 14 is operated (1001) so as to store the location of the mark 5 in the initial mark location storage portion 741 in the image sensor location change deciding portion 74 (1002). At this time, a reloadable ROM or a RAM having a backup power supply is used in the initial mark location storage portion 741 so that the memory of the initial mark location does not disappear even when

turning on electricity to the image signal processing unit is suspended because of the reason that a battery cable is disconnected and so on.

When setting of the initial mark location is completed, the following operation is performed thereafter in parallel with the normal collision avoidance operation described above. Namely, the location of the mark 5 during running is detected from the image data taken into the image memory 72 through the mark extracting portion 742 and the mark location detecting portion 743 (1003). Next, in the comparator 744, the location is compared with the data stored in the initial mark location storage portion 741 (1004). Here, when the mark location detected sequentially is equal to the initial mark location (1005), it is decided that the location of the image sensor has not been changed, processings described above in the image processing portion 73 and the danger avoidance deciding portion 75 are performed (1006 and 1007), and the process is returned to the operation of taking in the image of the next frame.

On the other hand, when two mark locations are different from each other as shown at 5 (an initial position) and 5' (a detected location during running) in the image window 15 shown in Fig. 4 in the processing (1005) in the comparator 744, it is decided that the image sensor has changed with respect to the initialized location (1008), and a warning is given to the driver through the warning issuance deciding unit 752 and the warning device 11 (1009). At this time, the warning is given to the driver while changing the tone color or the like so as not to confuse with the collision avoidance warning such as preceding vehicle abnormal approach and car lane jutting out. Further, transmission of an image signal from the image memory 72 to the image processing portion 73 is stopped, and the danger avoidance deciding function is suspended until the image sensor location is readjusted to the initial location.

According to the present embodiment, it is possible to always monitor the location change of the image sensor by extracting the mark location out of image data taken in sequentially and comparing this mark location with the initial location. As a result, it is possible to prevent such a problem that an erroneous distance between vehicles is computed using a distance A' in an image window in a state that the image sensor is deviated, thus giving inappropriate risk decision when risk decision is ought to be made originally by computing the distance from a preceding vehicle using a distance A in the image window as shown in Fig. 4.

Next, a second embodiment of the present invention will be described with reference to Fig. 5 and Fig. 6. In the present embodiment, a bonnet mascot 16 fitted to the bonnet of its own vehicle is utilized in place of the mark 5 stuck to the windshield 3 in the first embodiment. In the present embodiment, the image sensor 2 is installed so that the bonnet mascot 16 is located within an image pickup area 4 thereof, and the initialized location and a detected location 16' during running of the bonnet mascot 16 within the image window 15 such as

shown in Fig. 6 are compared sequentially with each other, thereby to monitor and decide the location change of the image sensor. In the structure and the operation, the mark 5 is only replaced with the bonnet mascot 16 with respect to the first embodiment shown in Fig. 1 to Fig. 3, and entirely similar effects as the first embodiment are obtainable. Furthermore, since the operation for sticking the mark 5 later becomes unnecessary in the present embodiment, it is possible to reduce mandays as compared with the first embodiment.

The bonnet mascot fitted to the bonnet of its own vehicle has been utilized in the present embodiment, but it is a matter of course that similar effects are obtainable when any of a part of the bonnet, an automobile inspection seal pasted to the windshield, a part of ceiling or the like that is fixed to its own vehicle is used in place of the bonnet mascot.

Next, a third embodiment of the present invention will be described with reference to Fig. 7 to Fig. 10. What differs from the first embodiment in the structure of the present embodiment is a fact that the image sensor 2 is fitted to its own vehicle 1 through a universal joint 17 that is able to be turned freely in a vertical direction  $R_b$  and in a horizontal direction  $R_a$  by means of a motor as shown in Fig. 7, and furthermore, is a fact that the comparator 744 and the joint 17 are connected through an image sensor direction control unit 76 as shown in Fig. 8.

The operation of the present embodiment becomes similar to that of the first embodiment shown in Fig. 3 when deviation of a mark from the initial location is not detected in the comparator 744 as shown in the flow 1002 to 1007 in Fig. 9. On the other hand, when the deviation is detected (1005), it is decided in the image sensor direction control unit 76 whether the deviation quantity is correctable or not (1010). When correction is possible, it is computed in which direction and to what extent the angle of the image sensor is to be changed based on the magnitudes  $a$  and  $b$  in the horizontal direction and the vertical direction of the mark deviation quantity shown in Fig. 10 (1011), and the universal joint 17 is driven by the motor, thereby to correct so that the mark location 5' coincides with the initial location 5 (1012). However, when it is decided in the processing 1010 that the required correction quantity in the image sensor direction is out of the movable range of the joint 17 (1013), a warning is given to the driver through the warning issuance deciding unit 752 and the warning device 11 (1014).

In the present embodiment, when deviation of the image sensor is produced, it is corrected automatically on the side of the device. Therefore, an effect that the driver is released from readjustment work is obtainable in addition to the effect of the first embodiment.

Next, a fourth embodiment of the present invention will be described with reference to Fig. 11. The present embodiment is similar to the third embodiment in that the direction of the image sensor is corrected automatically, but differs therefrom in a point that only an image pickup portion 210 consisting of a lens 201 and a CCD element 202 is driven by means of a motor contained in the image

sensor 2 without changing the direction of the whole image sensor by means of the joint 17.

In the present embodiment, since the weight of the driving portion is reduced substantially, the response speed of the image pickup system to a correction signal is improved and the safety is improved further in addition to the effect of the third embodiment.

Next, a fifth embodiment of the present invention will be described with reference to Fig. 10, Fig. 12 and Fig. 13. What differs from the first embodiment in point of the structure of the present embodiment is the fact that an image data correcting portion 77 for performing correction and storage of data is provided between the image memory 72 and the image processing portion 73 as shown in Fig. 12, thereby to feed back the result of the comparator 744 to the image data correcting portion 77.

The operation of the present embodiment becomes similar to that in the first embodiment shown in Fig. 3 when deviation of the mark with respect to the initial location is not detected in the comparator 744 as shown in the flow from 1002 to 1007 in Fig. 13. On the other hand, when deviation is detected (1005), it is decided in the image correcting portion 77 whether the deviation quantity is correctable in the image window or not (1015). When correction is possible, it is computed in which direction and to what extent the image data are to be changed based on the magnitudes  $a$  and  $b$  in a horizontal direction and a vertical direction of mark deviation quantities  $a$  and  $b$  shown in Fig. 10 (1016), and the image data are corrected based on the computed quantities (1017). For example, as a simple correction method, there is a method of adding to or subtracting from all the data in the field of view vertically or horizontally by the pixel portion that the mark is deviated. Thereafter, the processes thereafter (1006, 1007) are performed using corrected data. When it is decided in the process 1015 that the required correction quantity of the image data is out of the movable range in the image window (1018), however, a warning is given to a driver through the warning issuance deciding unit 752 and the warning device 11 (1019).

In the present embodiment, similar effects as those in the third and the fourth embodiments are obtainable, but a mechanism for rotating the image sensor becomes no longer required, thus producing an effect that weight and cost are reduced and reliability is also improved remarkably in addition to the above.

Next, a sixth embodiment will be described with reference to Fig. 14 and Figs. 15A and 15B. In Fig. 14, a state '1' in which a vehicle jams on the brakes is drawn one over the other by comparing with a normal running state 1, but an image sensor 2 installed in vehicle is changed with respect to a normal position 2 in this state. Further, a posture change of this kind is also produced in running a bad road such as shown in Fig. 15B. As a result, the image pickup area also changes from 4 to 4'; and the relative relationship between a location of a running vehicle and a practical distance between vehicles in the image window changes, thus causing erroneous

judgement on the risk. In the present embodiment, the posture change of a vehicle is detected based on the information of height sensors 18a and 18b, an accelerometer 19 or the like arranged in front and in the rear of the vehicle. When a posture change is detected, it is decided that there is a possibility of erroneous judgement on the risk, and the transmission of an image signal from the image memory 72 to the image processing portion 73 in the image signal processing unit 7 shown in Fig. 2 is suspended. Then, when such a state is calmed down and the posture change is also calmed down, the image signal transmission from the image memory 72 to the image processing portion 73 is restarted.

In the present embodiment, being different from those embodiments that have been described so far, it is possible to prevent occurrence of erroneous decision on the risk that could occur even when the direction of the image sensor does not change with respect to initialization.

According to the present invention, an image pickup device has been installed so that a mark for specifying a mounting location of the image pickup device falls within the image pickup area as described in detail above. Thus, it is possible, even when a recognition location of the image pickup device changes as time elapses with respect to the initialized location, to prevent erroneous decision of the image processing unit based on the change. To be concrete, in an environment recognition device for a vehicle, it is possible to give a proper decision on a distance between vehicles for instance by providing means for recognizing and comparing mark locations picked up sequentially by an image pickup device with respect to the initial location of the mark in an image pickup area, and by informing by an alarm or the like a driver that the installation location of the image pickup device is inappropriate and required to be corrected, correcting the mounting location of the image pickup device automatically or correcting image data when the mark locations recognized sequentially change with respect to the initialized location.

### Claims

1. An environment recognition device using an image pickup device for recognizing environment by signal processing of image pickup data obtained from an image pickup device (2), characterized in that there is provided a mark (5) for specifying a location of mounting said image pickup device (2) in an image pickup area (4) of said image pickup device (2).
2. A vehicle provided with an image pickup device (2) for obtaining peripheral environmental information as image data, characterized in that there is provided a mark (5) for giving mounting location data of said image pickup device (2) as one of said image data in an image pickup area (4).

3. An image pickup device for a vehicle mounted on a vehicle (1) and outputting environmental information inside and outside the vehicle (1) as image data characterized in that a mark (5) showing a location for mounting said image pickup device (2) is installed so as to fall within an image pickup area (4) thereof.
4. A method of recognizing environment from image pickup data by image processing of image pickup data picked up by an image pickup device (2), characterized in that the data showing the location of mounting said image pickup device (2) are used for detecting deviation of a field of view of the image pickup device (2).
5. An environment recognition device for a vehicle using an image pickup device having an image pickup device (2) installed in vehicle for picking up an image of the exterior of a vehicle (1), image processing means (7) for deciding existence of a state bringing a danger to said vehicle (1) by using image pickup data of said image pickup device (2), and warning means (11), when a state that brings a danger is recognized by said image processing means (7), for alerting a driver to that effect, characterized in that a mark (5) is stuck to a fixed portion of a vehicle (1) that falls within an image pickup area (4) of said image pickup device (2), memory means (72) for storing the initial location of said mark (5) and detecting means (74) for detecting said mark location sequentially while the device is in operation are provided in said image processing means (7), and, when the mark location detected sequentially by said detecting means (74) has changed with respect to the initial location of said mark (5), a driver is alerted to that effect through said warning means (11).
6. An environment recognition device for a vehicle using an image pickup device having an image pickup device (2) installed in vehicle for picking up an image of the exterior of a vehicle (1), image processing means (7) for deciding existence of a state bringing a danger to said vehicle (1) by using image pickup data of said image pickup device (2), and warning means (11), when a state that brings a danger is recognized by said image processing means (7), for alerting a driver to that effect, characterized in that a mark (5) is stuck to a fixed portion of a vehicle (1) that falls within an image pickup area (4) of said image pickup device (2), memory means (72) for storing the initial location of said mark (5) and detecting means (74) for detecting said mark location sequentially while the device is in operation are provided in said image processing means (7), and an image signal is continued to be transmitted from said image pickup device (2) to said image processing means (7) except for the change of the mark location detected sequentially by said detect-
- 5
- 10
- 15
- 20
- 25
- 30
- 35
- 40
- 45
- 50
- 55
- ing means (74) with respect to the initial location of said mark (5).
7. An environment recognition device for a vehicle using an image pickup device having an image pickup device (2) installed in vehicle for picking up an image of the exterior of a vehicle (1), image processing means (7) for deciding existence of a state bringing a danger to said vehicle (1) by using image pickup data of said image pickup device (2), and warning means (11), when a state that brings a danger is recognized by said image processing means (7), for alerting a driver to that effect, characterized in that a mark (5) is stuck to a fixed portion of a vehicle (1) that falls within an image pickup area (4) of said image pickup device (2), memory means (72) for storing the initial location of said mark (5) and detecting means (74) for detecting said mark location sequentially while the device is in operation are provided in said image processing means (7), and an image signal transmission from said image pickup device (2) to said image processing means (7) is suspended when the mark location detected sequentially by said detecting means (74) has changed with respect to the initial location of said mark (5).
8. An environment recognition device for a vehicle using an image pickup device having posture change sensors (18a, 18b) for sensing a posture change of a vehicle, an image pickup device (2) installed in vehicle for picking up the image of the exterior of a vehicle, image processing means (7) for deciding the existence of a state that brings a danger to said vehicle (1) using image data of said image pickup device (2), and alerting means, when a state that brings a danger is recognized by said image processing means (7), for alerting a driver to that effect, characterized in that, when a posture change of a vehicle (1) is sensed by said posture change sensors (18a, 18b), the image signal transmission from said image pickup device (2) to said image processing means (73) is suspended.
9. An environment recognition device for a vehicle using an image pickup device having an image pickup device (2) installed in vehicle for picking up an image of the exterior of a vehicle (1), image processing means (7) for deciding existence of a state bringing a danger to said vehicle (1) by using image pickup data of said image pickup device (2), and warning means (11), when a state that brings a danger is recognized by said image processing means (7), for alerting a driver to that effect, characterized in that said image pickup device (2) is installed within the image pickup area (4) of said image pickup device (2) so that the fixed portion of a vehicle (1) is picked up, memory means (72) for storing the initial location of the fixed portion of said

- vehicle (1) and detecting means (74) for detecting fixed portion of said vehicle sequentially during the operation of the device are provided in the image processing means (7), and, when the location of the fixed portion of the vehicle detected sequentially by detecting means (74) has changed with respect to the initial location of the fixed portion of said vehicle (1), a driver is alerted to that effect through said warning means (11).
10. An environment recognition device for a vehicle using an image pickup device according to Claim 9, wherein the fixed portion of a vehicle (1) is a hood in front of a windshield (3).
11. An environment recognition device for a vehicle using an image pickup device according to Claim 9, wherein the fixed portion of a vehicle (1) is a seal stuck on a windshield (3).
12. An environment recognition device for a vehicle using an image pickup device according to Claim 9, wherein the fixed portion of a vehicle (1) is a trunk hood in the rear of a rear windshield.
13. An environment recognition device for a vehicle using an image pickup device having an image pickup device (2) installed in vehicle for picking up an image of the exterior of a vehicle (1), image processing means (7) for deciding existence of a state bringing a danger to said vehicle (1) by using image pickup data of said image pickup device (2), and warning means (11), when a state that brings a danger is recognized by said image processing means (7), for alerting a driver to that effect, characterized in that said image pickup device (2) is fixed in vehicle through a direction control unit (76) that is able to change an image pickup direction thereof and a mark (5) is stuck on a fixed portion of a vehicle (1) that falls within an image pickup area (4) of said image pickup device (2), memory means (72) for storing the initial location of said mark (5) and detecting means (74) for detecting said mark location sequentially while the device is in operation are provided in said image processing means (7), and, when the mark location detected sequentially by said detecting means (74) has changed with respect to the initial location of said mark (5), the direction of said image pickup device (2) is adjusted automatically so that the mark location coincides with the initial location of said mark (5) by driving the direction control unit (76) of said image pickup device (2).
14. An environment recognition device for a vehicle using an image pickup device having an image pickup device (2) installed in vehicle for picking up an image of the exterior of a vehicle (1), image processing means (7) for deciding existence of a state bringing a danger to said vehicle (1) by using

- 5 image pickup data of said image pickup device (2), and warning means (11), when a state that brings a danger is recognized by said image processing means (7), for alerting a driver to that effect, characterized in that a mark (5) is stuck to a fixed portion of a vehicle (1) that falls within an image pickup area (4) of said image pickup device (2), memory means (72) for storing the initial location of said mark (5) and detecting means (74) for detecting said mark location sequentially while the device is in operation are provided in said image processing means (7), and, when the mark location detected sequentially by said detecting means (74) has changed with respect to the initial location of said mark (5), the image data taken into said image processing means (7) are corrected in accordance with the change quantity and the direction of the change.
- 10 15. An environment recognition device for a vehicle using an image pickup device according to Claim 5, wherein memory means (72) for storing an initial location of a mark (5) is a read-only memory (ROM) that is rewritable from the outside.
- 20 16. An environment recognition device for a vehicle using an image pickup device according to Claim 5, wherein memory means (72) for storing an initial location of a mark (5) is a random access memory (RAM) having a power source for backing up so that the memory is not erased even when an engine is stopped.
- 25 17. An environment recognition device for a vehicle using an image pickup device according to Claim 13, wherein direction control of the image pickup device (2) is made by a motor.
- 30 18. An environment recognition device for a vehicle using an image pickup device according to Claim 13, wherein it is only the image pickup system (210) in an image pickup device composed of a lens (201) and a charge coupled device (CCD) element (202) that the direction changes.
- 35 19. An environment recognition device for a vehicle using an image pickup device according to Claim 8, wherein a posture change of a vehicle (1) is presumed by outputs of a height sensors (18a, 18b) provided on a suspension.
- 40 20. An environment recognition device for a vehicle using an image pickup device according to Claim 8, wherein a posture change of a vehicle (1) is presumed by an output of an accelerometer (19) fitted on a vehicle body.
- 45 50 55

F I G . 1

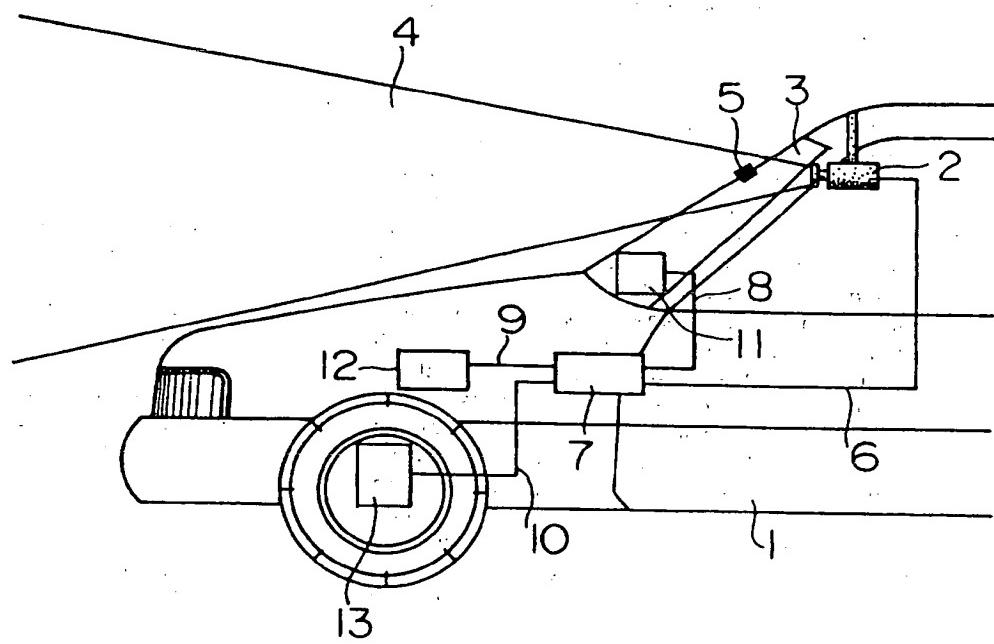


FIG. 2

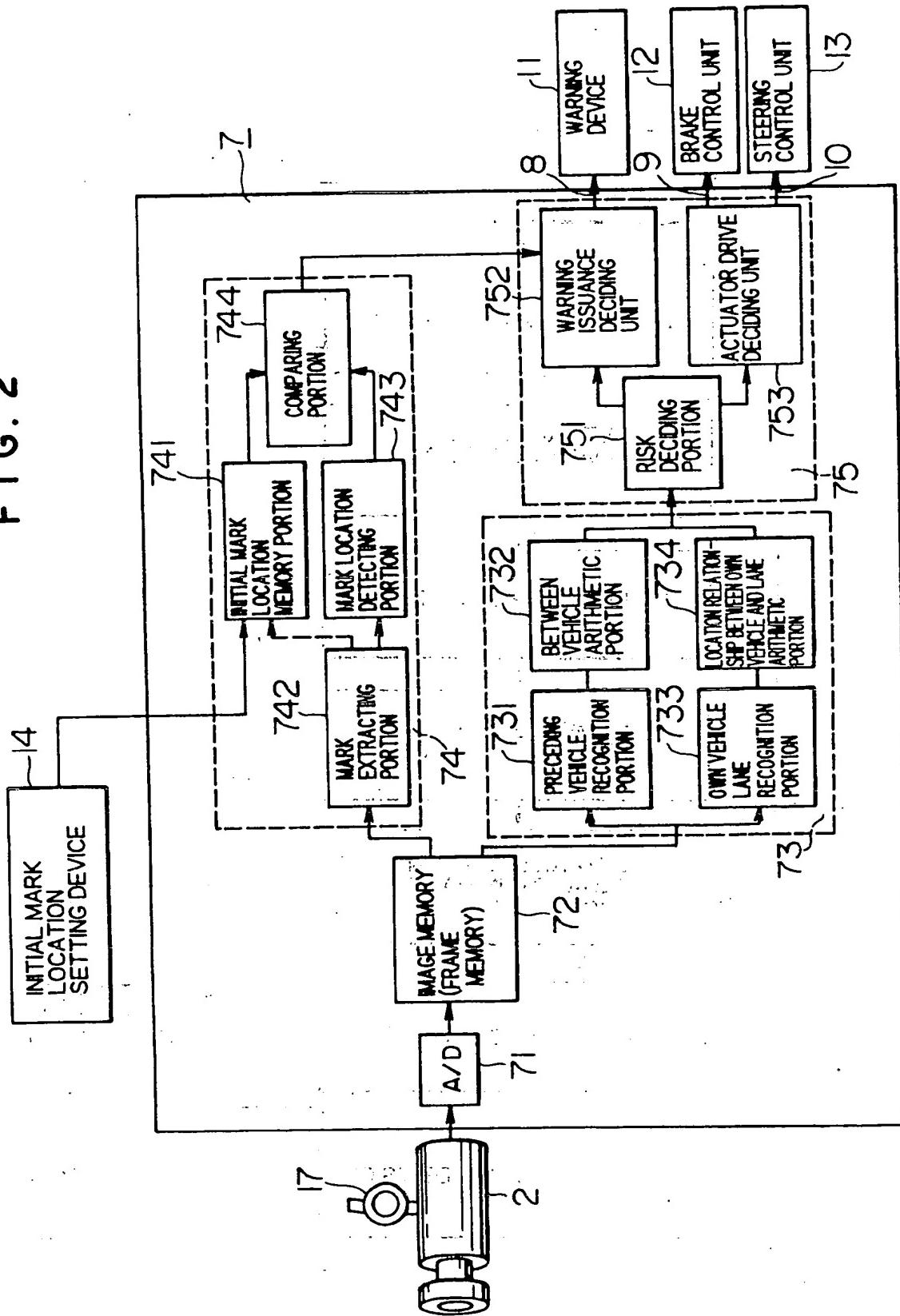
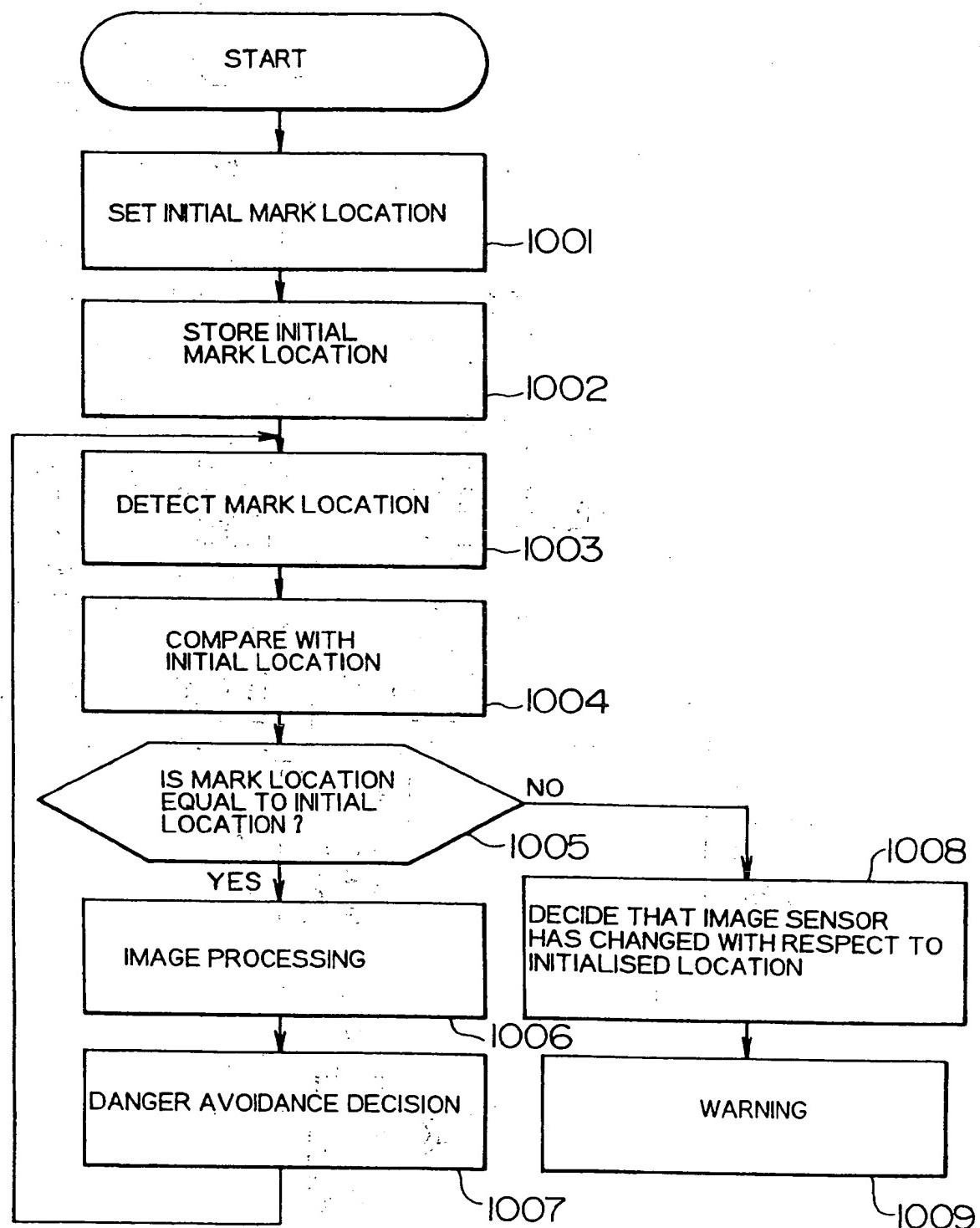
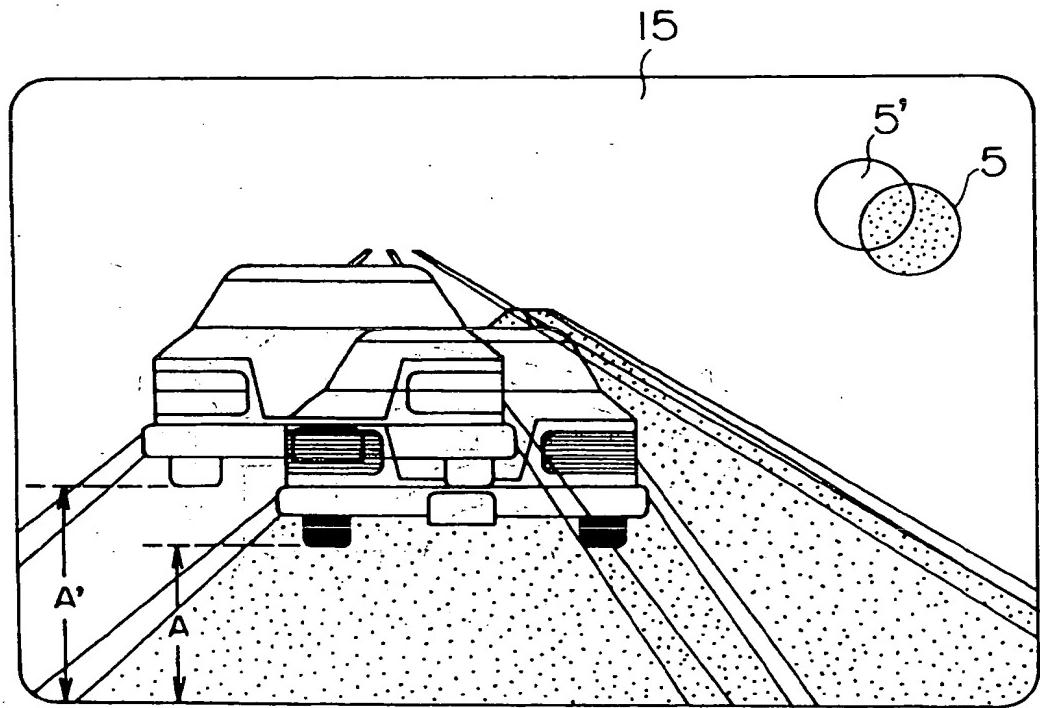


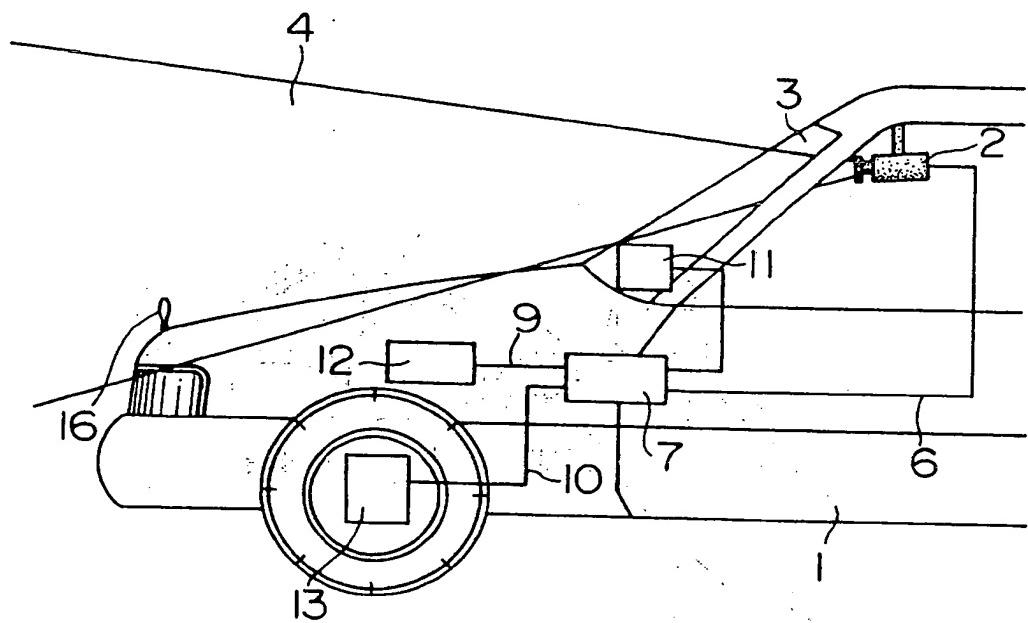
FIG. 3



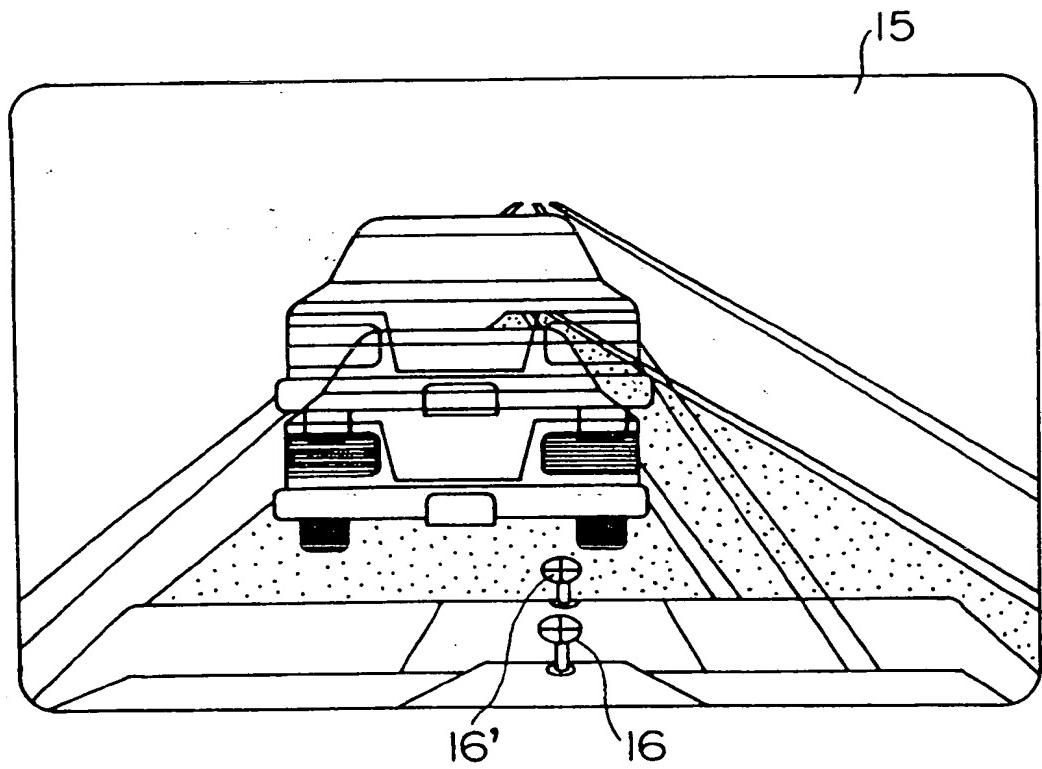
F I G . 4



F I G . 5



F I G . 6



F I G . 7

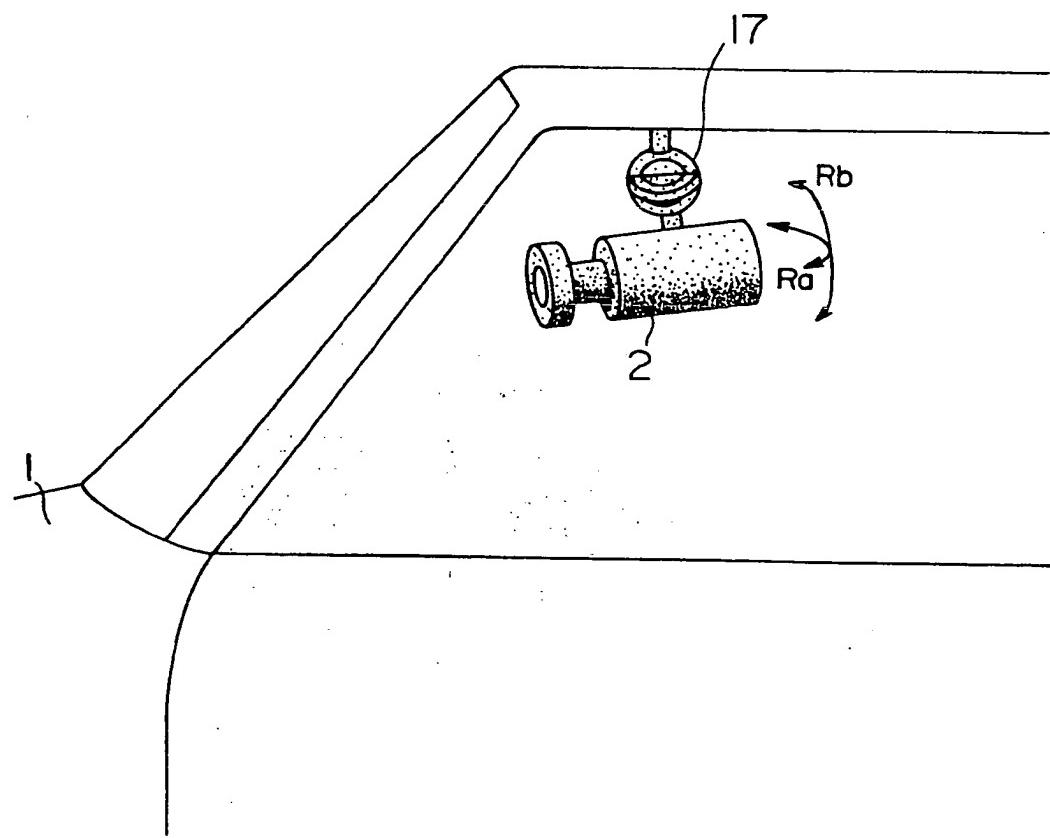
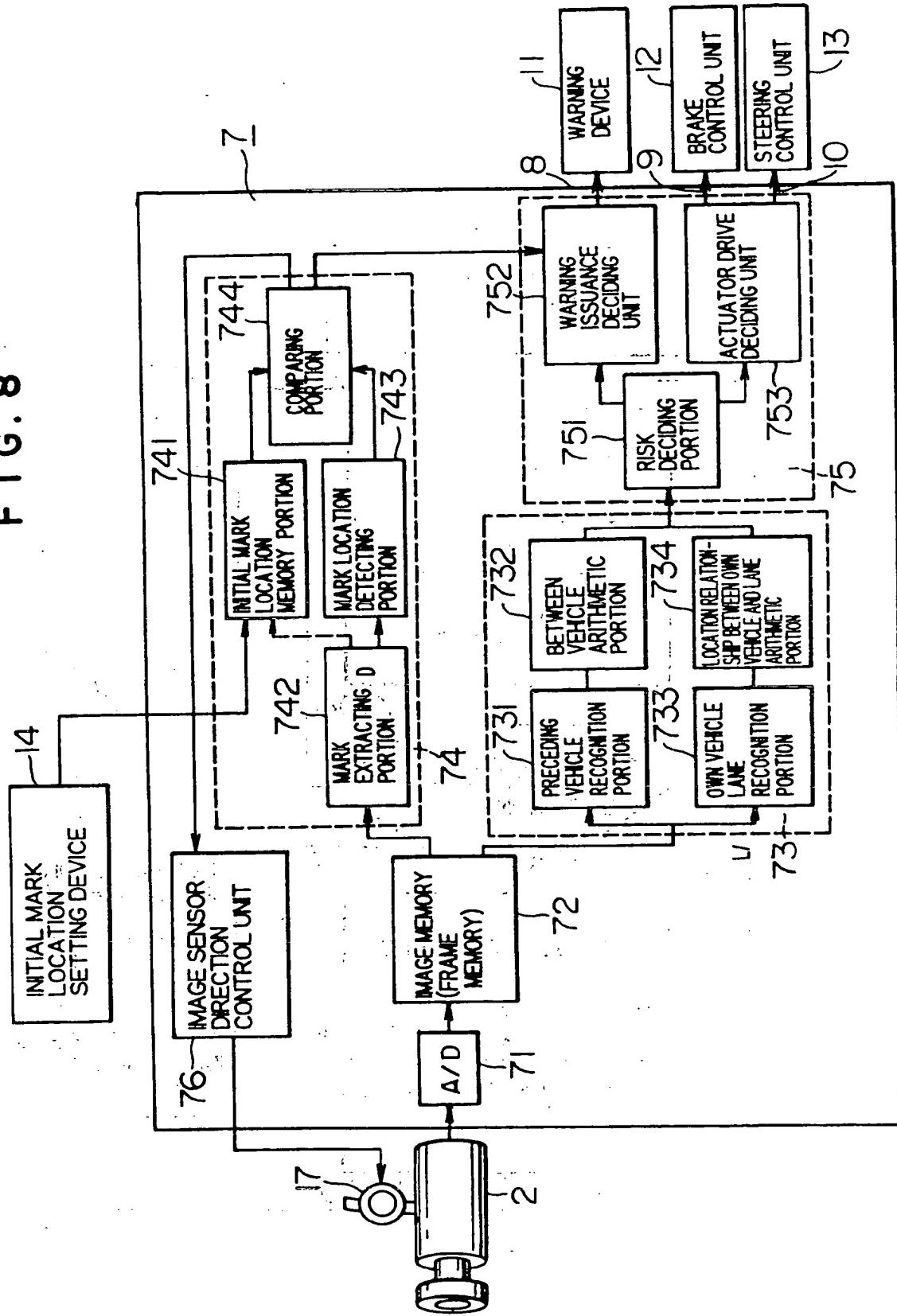
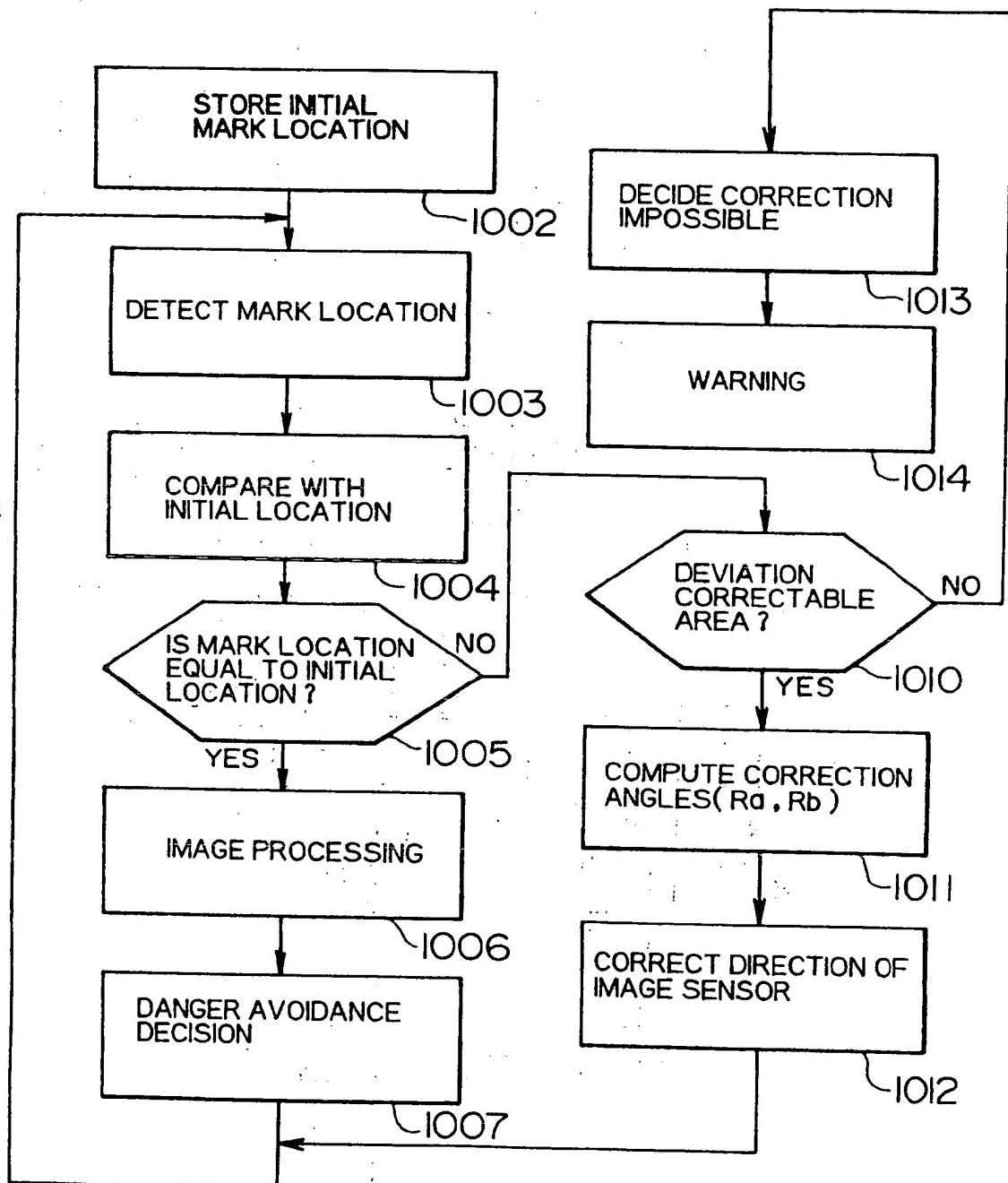


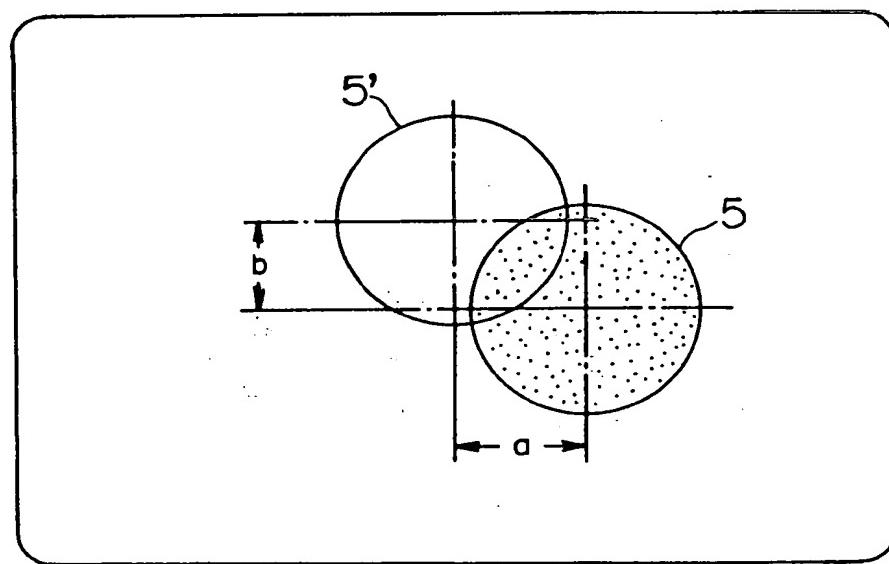
FIG. 8



F I G . 9



F I G. IO



F I G. II

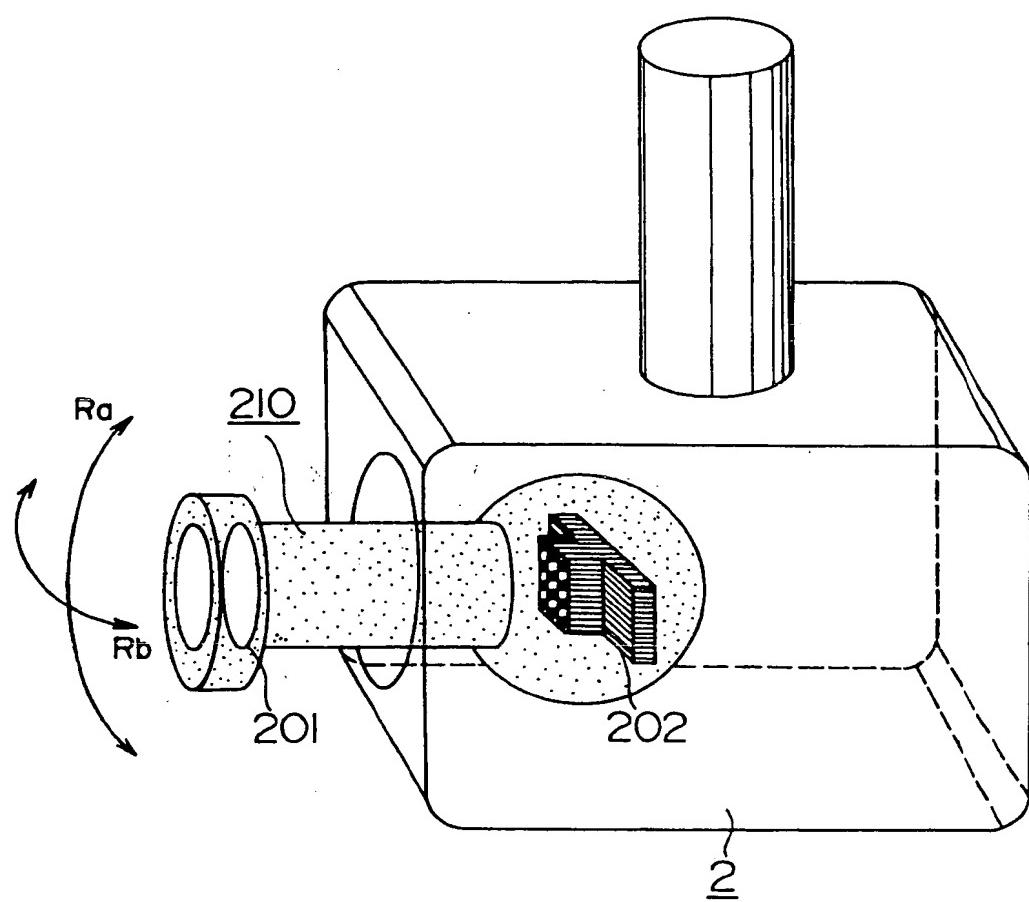


FIG. 12

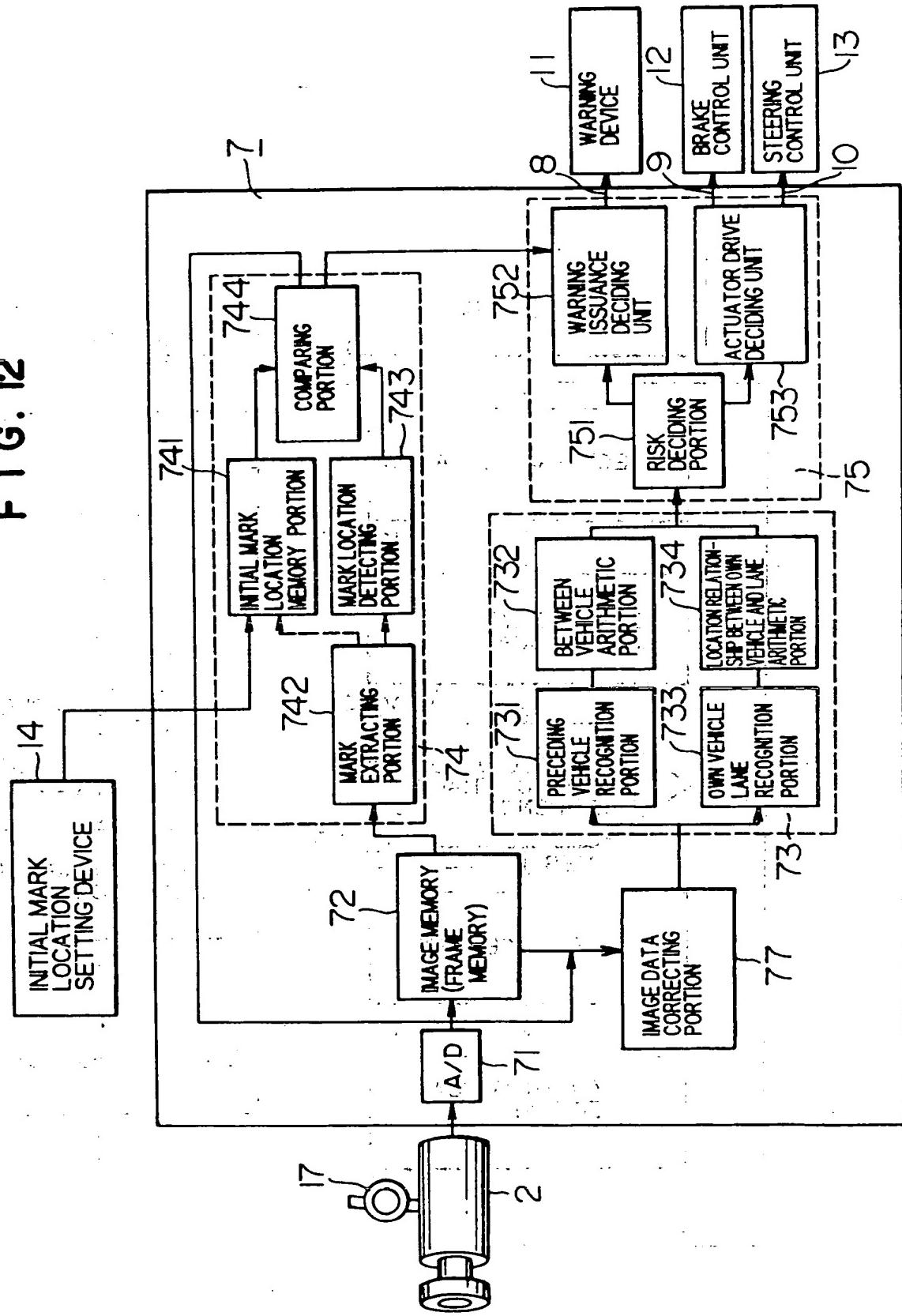
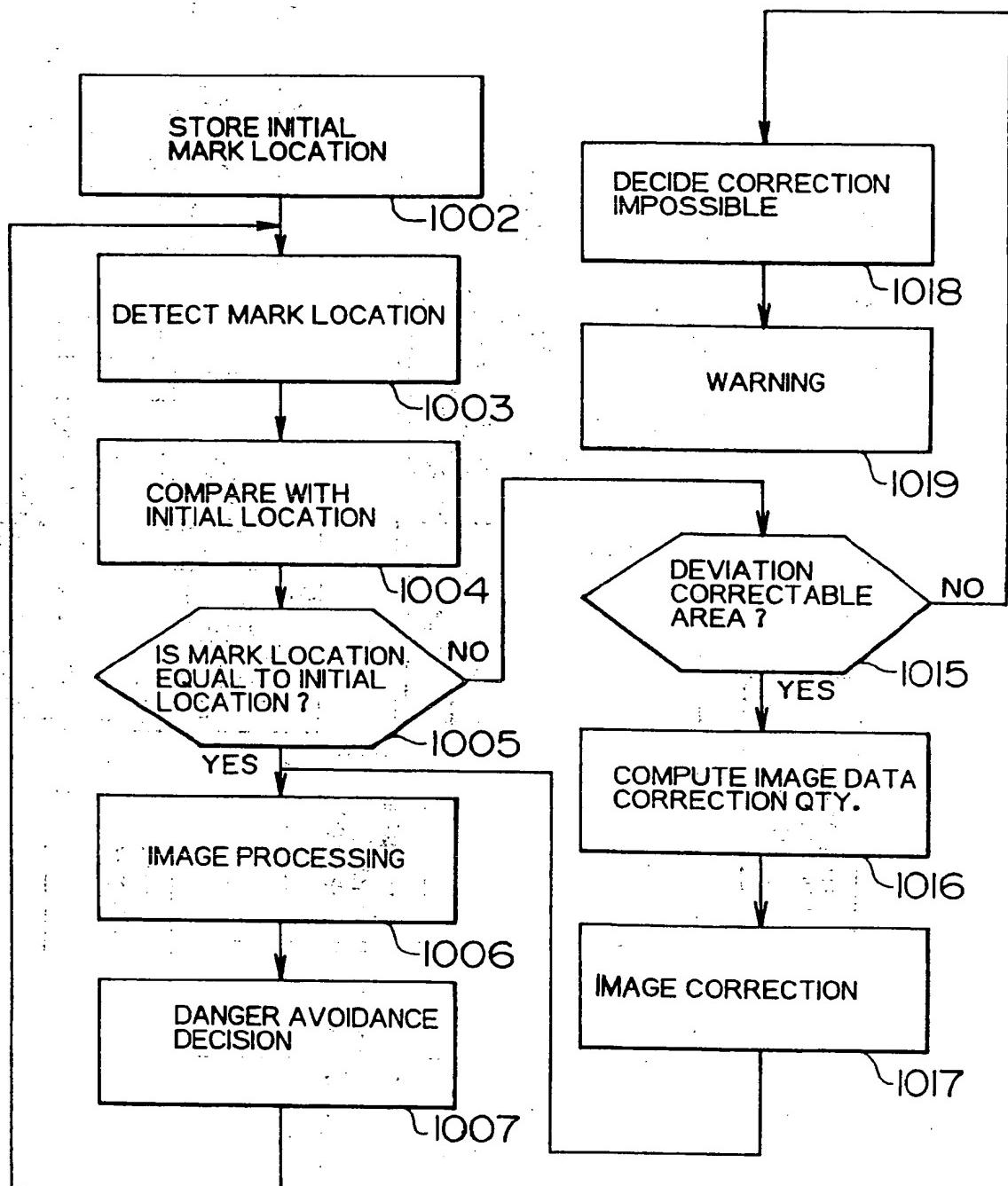
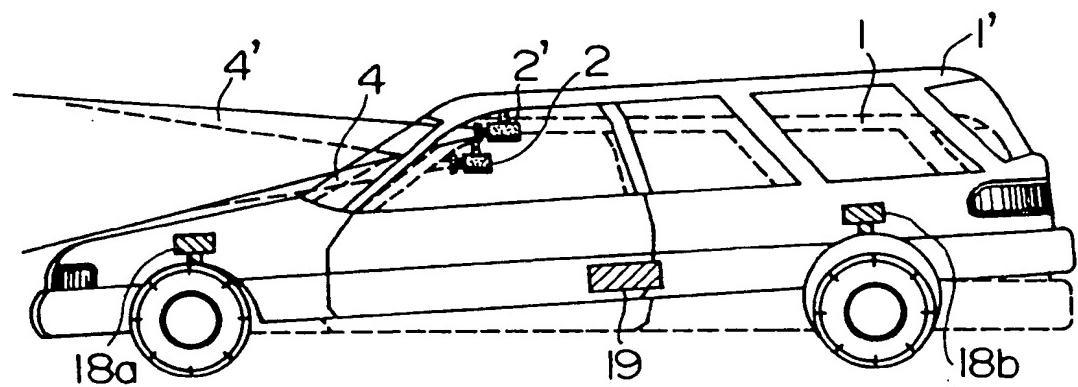


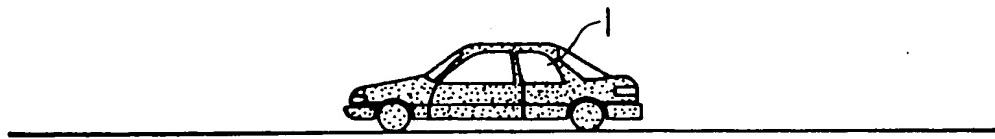
FIG. 13



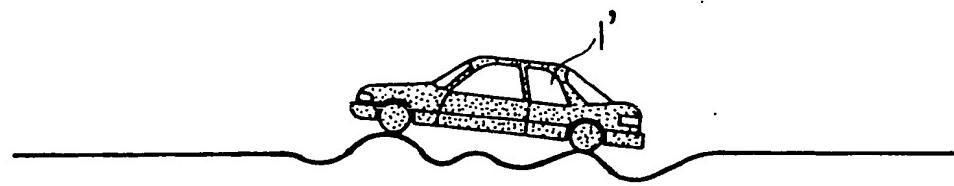
F I G . 14



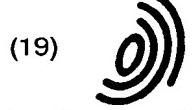
F I G . 15A



F I G . 15B



**THIS PAGE BLANK (USPTO)**



(19)

Europäisches Patentamt

European Patent Office

Office européen des brevets



(11)

EP 0 691 599 A3

(12)

## EUROPEAN PATENT APPLICATION

(88) Date of publication A3:  
06.03.1996 Bulletin 1996/10(51) Int. Cl.<sup>6</sup>: G05D 1/03(43) Date of publication A2:  
10.01.1996 Bulletin 1996/02

(21) Application number: 95303783.5

(22) Date of filing: 02.06.1995

(84) Designated Contracting States:  
DE FR GB

• Tanaka, Yasunari

Mito-shi (JP)

• Ondoh, Eiryoh

Hitachinaka-shi (JP)

• Shioya, Makoto

Tokyo (JP)

(30) Priority: 05.07.1994 JP 153288/94

(74) Representative: Molyneaux, Martyn William  
Langner Parry  
52-54 High Holborn  
London WC1V 6RR (GB)

(71) Applicant: HITACHI, LTD.

Chiyoda-ku, Tokyo 100 (JP)

(72) Inventors:

• Takano, Kazuaki

Mito-shi (JP)

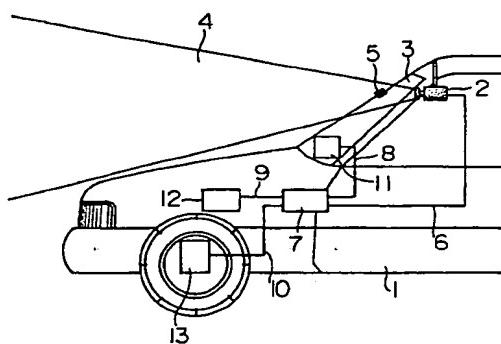
• Monzi, Tatsuhiko

Hitachinaka-shi (JP)

## (54) Environment recognition device provided with image pickup device

(57) An environment recognition device formed in such a manner that an image sensor (2) is installed so that an image sensor mounting location recognition mark (5) falls within an image pickup area (4), means for comparing mark locations the images of which are picked up sequentially by means of the image sensor (2) with respect to the initial location of the recognition mark (5) in the image pickup area (4) is provided, and, when it is detected that the mark location recognized sequentially has changed with respect to the initial location, an indication signal for indicating that correction of the location of installing the image sensor (2) is required is outputted, thereby to prevent erroneous decision in image processing when the mounting position changes by vibration, contact or the like.

## F I G . 1



EP 0 691 599 A3



European Patent  
Office

## EUROPEAN SEARCH REPORT

Application Number  
EP 95 30 3783

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int.Cl.6)												
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim													
X	EP-A-0 132 151 (TOYOTA) * page 5, line 6 - page 8, line 11 * ---	1-4	G05D1/03												
A	PROCEEDINGS OF THE 1992 IEEE/RSJ INTERNATIONAL CONFERENCE ON INTELLIGENT ROBOTS AND SYSTEMS, vol.3, 7 July 1992, USA pages 2195 - 2202 H.ISHIGURO ET AL 'ACTIVE VISION BY MULTIPLE VISUAL AGENTS' * the whole document *	1-9, 13, 14													
A	US-A-3 882 268 (Y.OGAWA ET AL) * the whole document *	1-9, 13, 14													
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)												
			G05D												
<p>The present search report has been drawn up for all claims</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%;">Place of search</td> <td style="width: 33%;">Date of completion of the search</td> <td style="width: 34%;">Examiner</td> </tr> <tr> <td>THE HAGUE</td> <td>4 December 1995</td> <td>Kelperis, K</td> </tr> <tr> <td colspan="3"> <b>CATEGORY OF CITED DOCUMENTS</b>            X : particularly relevant if taken alone            Y : particularly relevant if combined with another document of the same category            A : technological background            O : non-written disclosure            P : intermediate document         </td> </tr> <tr> <td colspan="3">           T : theory or principle underlying the invention            E : earlier patent document, but published on, or after the filing date            D : document cited in the application            L : document cited for other reasons            .....            &amp; : member of the same patent family, corresponding document         </td> </tr> </table>				Place of search	Date of completion of the search	Examiner	THE HAGUE	4 December 1995	Kelperis, K	<b>CATEGORY OF CITED DOCUMENTS</b> X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ..... & : member of the same patent family, corresponding document		
Place of search	Date of completion of the search	Examiner													
THE HAGUE	4 December 1995	Kelperis, K													
<b>CATEGORY OF CITED DOCUMENTS</b> X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document															
T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ..... & : member of the same patent family, corresponding document															



European Patent  
Office

### CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

- All claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for all claims.
- Only part of the claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid,  
namely claims:
- No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

### LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirement of unity of invention and relates to several inventions or groups of inventions.

namely:

see sheet -B-

- All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.
- Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respects of which search fees have been paid,  
namely claims:
- None of the further search fees has been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims.  
namely claims:



European Patent  
Office

EP 95 30 3783 -B-

**LACK OF UNITY OF INVENTION**

The Search Division considers that the present European patent application does not comply with the requirement of unity of invention and relates to several inventions or groups of inventions, namely:

1. Claims 1-4,13,17,18:

Environment recognition device characterised by a mark for specifying location of mounting

2. Claims 5-12,14-16,19,20:

Environment recognition device having a memory and warning means